Advanced Technology and Manufacturing Institute

Nordson Asymtek DispenseMate D-583 System Operation

Revision	Date	Description	Curator
0	11/14/18	New document	Steven Kawula
1	11/27/18	Revised “System Operation for Basic Dispensing Process Programming and Execution” section. Added example of silicone dispense parameters (appendix).	Steven Kawula
2	2/15/19	Minor revisions to all sections of SOP	Steven Kawula

System Description

The Nordson Asymtek DispenseMate D-583 is a programmable three-axis gantry to enable controlled motion of a dispensing or jetting head. XY motion control is achieved through planar movement of the stage (max travel of 325 mm x 325 mm), while Z motion control is achieved through vertical movement of the dispensing head carriage (max travel of 75 mm). Control of the gantry motion and most deposition parameters is provided through an attached laptop with Fluidmove® for Windows® XP (FmXP) Version 5.3 software installed. This tool requires the following:

1. Clean dry air or dry nitrogen supply: 85 L/min, 620 kPa (3 CFM @ 90 psi)
2. Power: 100-240 VAC, 5 amps, 50/60 Hz, single phase

Depending on the application, several dispensing and jetting head attachments are available for attachment to the Nordson Asymtek DispenseMate D-583 gantry. At ATAMI, these attachments are as follows:

1. DV-7000 Heli-Flow™ Pump
2. DJ-9000 DispenseJet®
3. DV-01-S10 Syringe Valve 10cc
4. VK-01 DV-01 Spares Kit 10cc
5. Unity IC30 applicator*
    a. *Temperature control on this applicator is provided through attachment to a separate Unity controller
6. Plain syringe barrel

Safety and Equipment Care Considerations

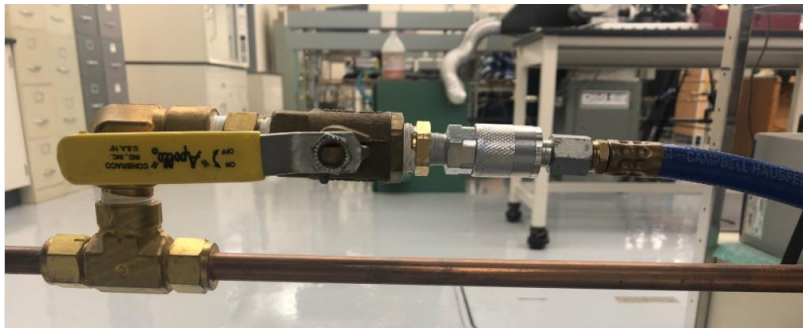
See “Safety” section of “DispenseMate® 580 Dispensing System User Guide” manual for details on safety when using or modifying the dispenser.

System Operation for Basic Dispensing Process Programming and Execution

The procedure described in this section is only intended as a basic introduction to setting up and executing programs using the dispensing tool. For a more comprehensive description of the software’s capabilities, consult the “Fluidmove for Windows XP Version 5.0 Software Manual” binder provided with the Nordson Asymtek DispenseMate D-583 tool.

Initial Dispensing Tool Setup

1. Turn on the dry nitrogen gas input to the dispenser



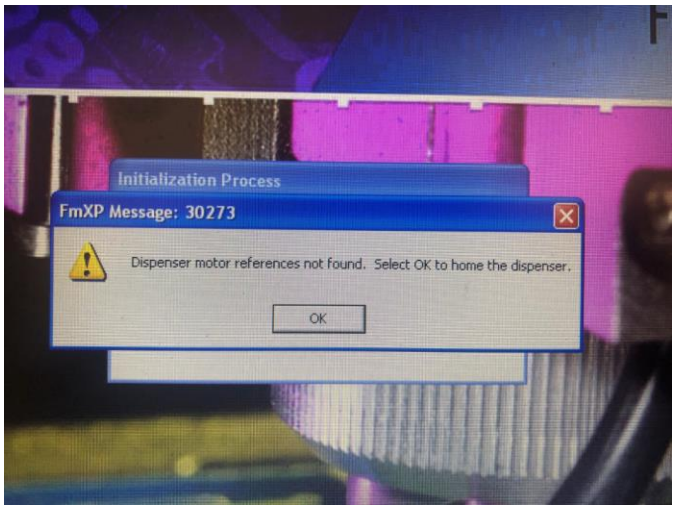
2. Ensure that the in-line air dryer is all the way open

3. Flip the power switch on the back panel of the dispenser

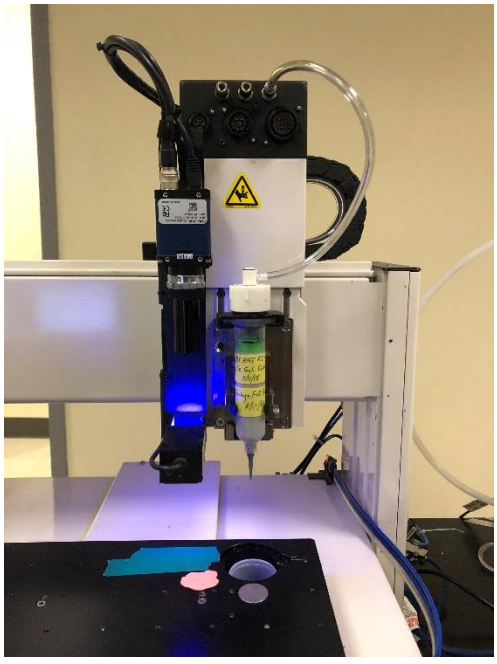
4. Press the green power button on the front panel of the dispenser to turn the tool on

5. After a few minutes, turn on the connected controller laptop
6. On the connected controller laptop desktop, double click the “FmXP” icon.

7. As the program starts up, it will display the following screen. Press “OK”.



8. Fill an empty syringe barrel with fluid, or obtain a pre-filled syringe barrel.
9. Attach a dispense nozzle tip to the syringe barrel. The exact nozzle tip design / diameter will depend on the application.
10. Load a syringe barrel (in this case 30 cc with attached 16 ga nozzle tip) onto the dispenser, as shown below. Note that the pressured air/gas line is attached to the rightmost silver connector on the dispenser.



Dispenser Robot Movement

To move the dispenser stage (X motion, Y motion), and the dispenser head (Z motion), the operator can use the connected laptop keyboard. Keyboard movement controls are as follows:

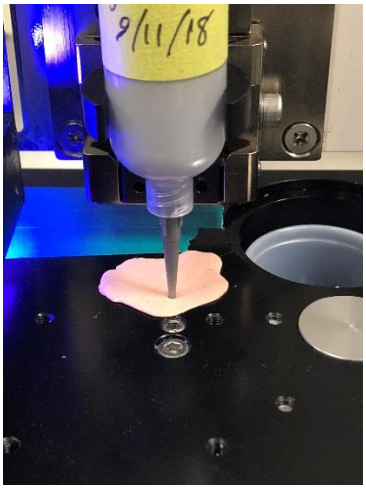
1. Positive X motion of dispenser nozzle relative to stage:
    a. Ctrl + Shift + Right Arrow (Fast)
    b. Ctrl + Right Arrow (Slow)
2. Positive Y motion of dispenser nozzle relative to stage:
    a. Ctrl + Shift + Up Arrow (Fast)
    b. Ctrl + Up Arrow (Slow)
3. Negative Z motion of dispenser nozzle relative to stage:
    a. In the absolute dispenser machine coordinates, raising the dispenser nozzle / gantry z-axis carriage corresponds to a decrease in the Z – coordinate value.
    b. Ctrl + Shift + Z + Up Arrow (Fast)
    c. Ctrl + Z + Up Arrow (Slow)

Initial X, Y, and Z Position Calibration

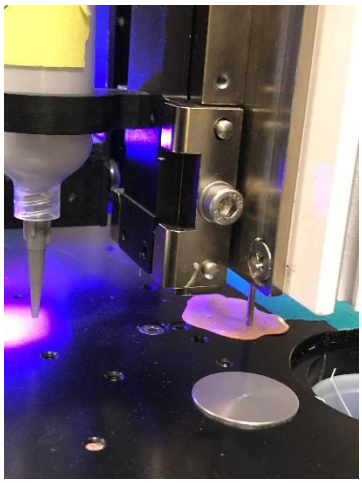
This calibration process is necessary to ensure that the dispenser camera, nozzle tip, and height sensing probe all move to the same X,Y, and Z position during program operation.

1. On the front panel of the dispenser, turn the grey knob CCW until the fluid pressure reads <1 psi, as shown below.

2. On the “FmXP” main menu, click “Run a Program”.
3. On the resulting “Production” window, click “Setup” > “Prompted Setup”.
4. Click “Next” on the “Clear work area”, “Check purge and weight cup”, “Change purge boot if necessary…”, “Install new needle, shield, etc.” windows, and “Done” on the “Press [Done] to run the Valve Offset process” window.
5. On the resulting “Machine Setup” window, press “Run to End”.
6. On the “Teach Safe Z height” window, type in 40 for the “Value” text field. Then press “Go to”, “Teach” and “Done”.
    a. The “Safe Z height” sets the absolute Z – height of the nozzle tip during uncontrolled movement within a dispensing program (i.e. between scripted commands).
7. On the “For Valve 1 align needle on mark” window, place a patch of silly putty beneath the nozzle location. Then slowly lower the nozzle z-height until the nozzle touches / makes a circular impression on the silly putty as shown below, and re-raise the nozzle away from the putty. Then press “Teach”.



8. On the “Align camera on needle mark and press [Teach]” window, move the dispenser stage until the cursor on the camera screen lies in the center of the mark on the silly putty made by the nozzle, Then press “Teach”.
9. On the “For Valve 1 align probe on mark” window, slowly lower the probe z-height until the probe touches / makes a circular impression on the silly putty as shown below, and re-raise the probe away from the putty. Then press “Teach”.



10. On the “Align camera on probe mark and press [Teach]” window, move the dispenser stage until the cursor on the camera screen lies in the center of the mark on the silly putty made by the probe, Then press “Teach”.
11. For the remaining prompted setup in the pop up window, follow the prompt in the windows using all the default options. (Click “no” when the prompt asks if you are installing a new syringe).
12. Press “Main” ( ) to go back to the FmXP main menu.

Dispense Parameter Programming

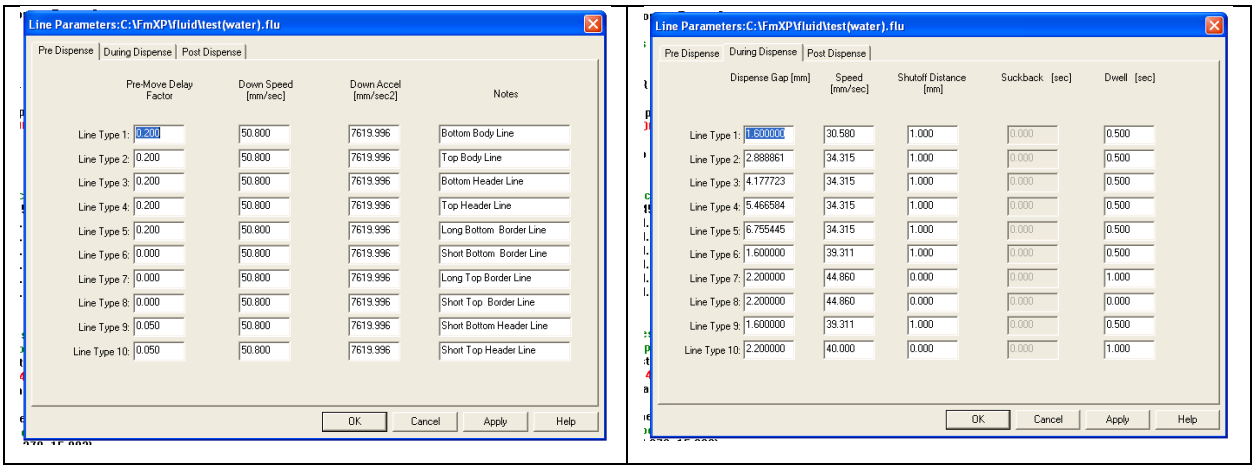
This section describes the method for specifying pre-set line and dot dispense parameters for use in later dispensing programs. These line and dot parameters are saved independently within FmXP separate from the user-written dispense program, with each set of parameters designated as “Line Type” or “Dot Type”. As shown in the **“Manual Dispense Program Scripting”** section, each dispensed line and dot within a user-written dispense program is linked to a desired set of parameters by specifying the Line or Dot Type within the code.

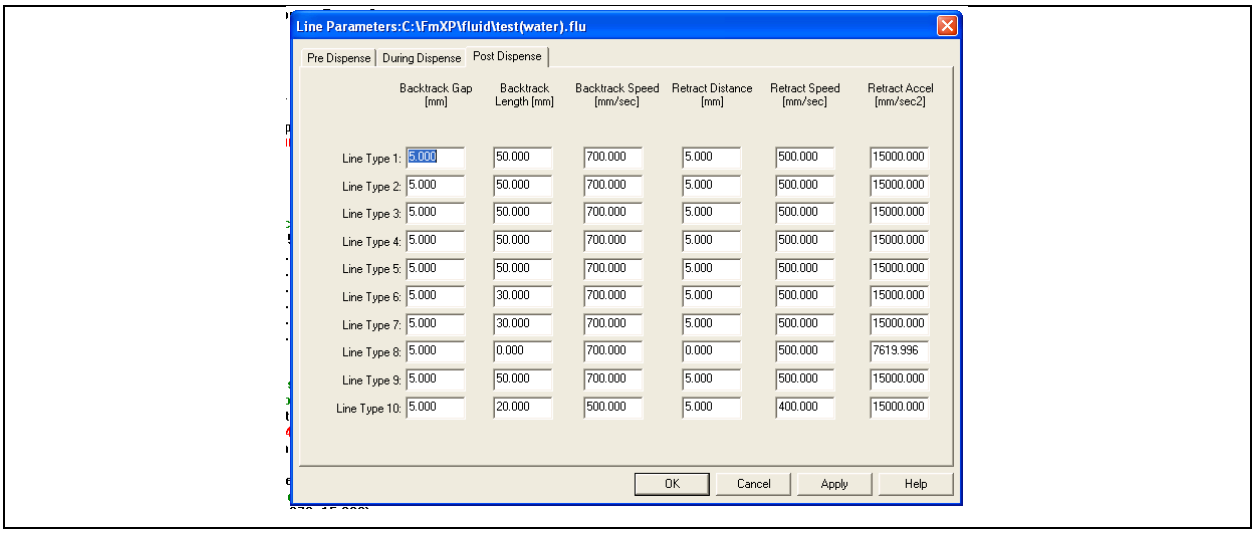
Note that dispensing pressure cannot be controlled in the FmXP software and must instead be manually set by rotating a knob on the dispenser.

1. On the FmXP main menu, click “Teach a Program”. Ignore the code displayed in the resulting programming window.
2. Setting dispense fluid pressure:

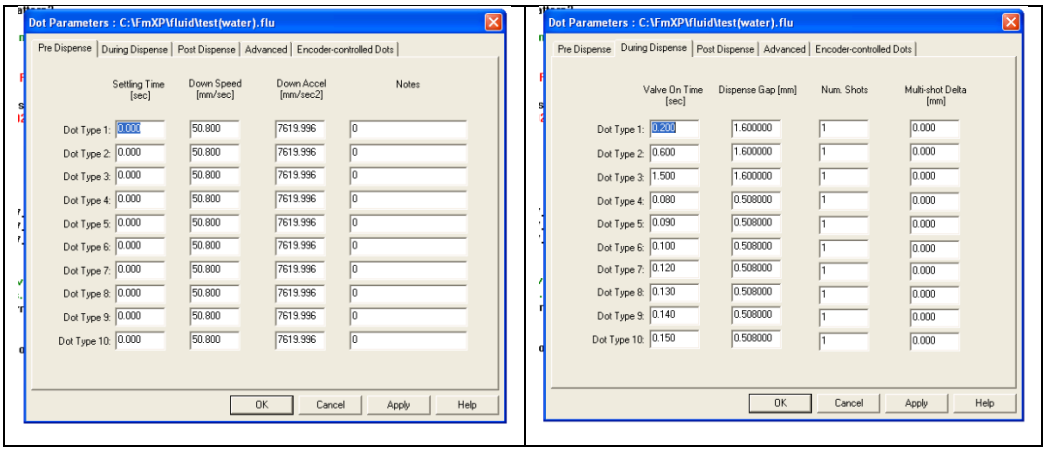
a. Rotate the gray knob on the dispenser's front panel until the target pressure is reached. With ATAMI line pressure, maximum fluid pressures of 70 – 75 psi are typically possible.

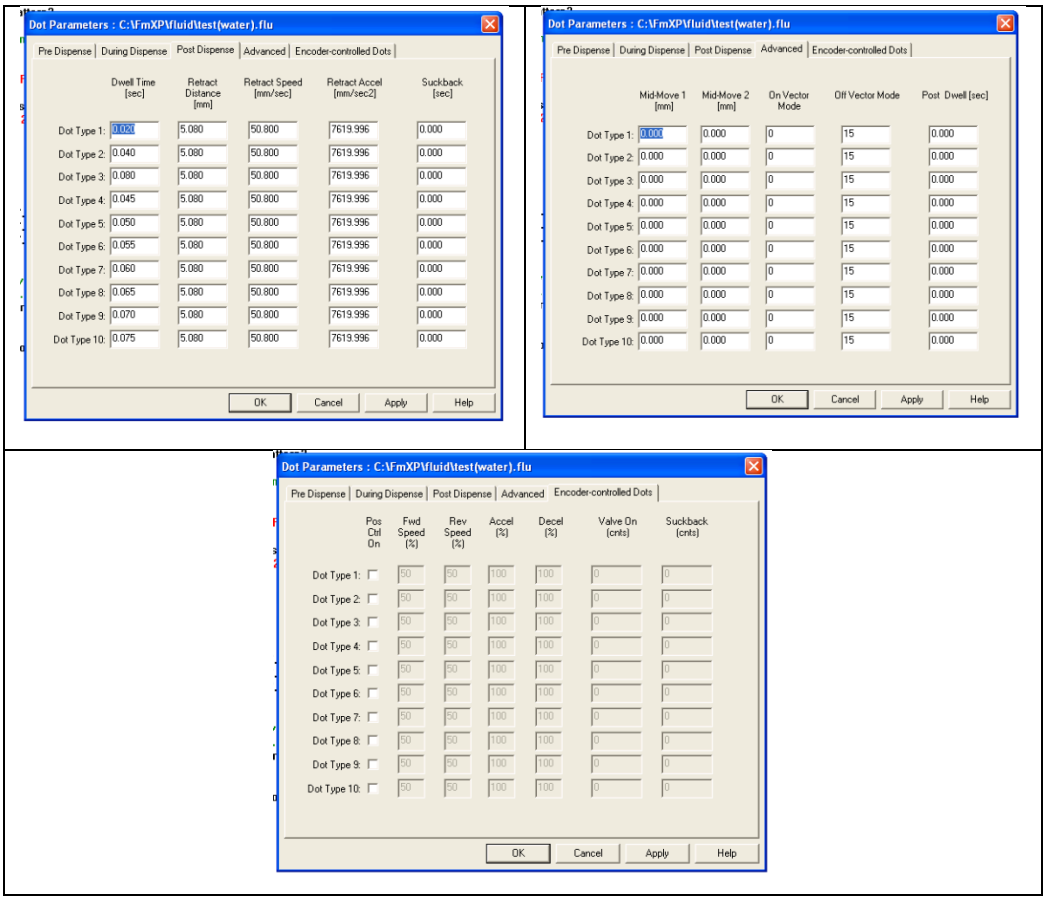
3. Setting line parameters:
    a. On the top menu of the programming window, click "Edit" > "Edit Line Parameters". A popup window with three tabs will be displayed as shown below, with separate lines titled "Line Type 1", "Line Type 2", "Line Type 3", etc…
        i. Each "Line Type" corresponds to a specific set of line dispense parameters which can be called within user-written dispense programs.
        ii. For a complete description of the significance of each line parameter, consult the **Fluidmove for Windows XP Version 5.0 Software Manual**
        iii. Note that only 10 sets of line parameters (aka "Line Type") can be saved within FmXP at a time
    b. To ensure that each parameter is saved, press "Apply" and "OK" before exiting the Edit Line Parameters window.





4. Setting dot parameters:
    a. On the top menu of the programming window, click “Edit” > “Edit Dot Parameters”. A popup window with five tabs will be displayed as shown below, with separate lines titled “Dot Type 1”, “Dot Type 2”, “Dot Type 3”, etc…
        i. Each “Dot Type” corresponds to a specific set of dot dispense parameters which can be called within user-written dispense programs.
        ii. For a complete description of the significance of each of dot parameter, consult the **Fluidmove for Windows XP Version 5.0 Software Manual**
        iii. Note that only 10 sets of dot parameters (aka “Dot Type”) can be saved within FmXP at a time
    b. To ensure that each parameter is saved, press “Apply” and “OK” before exiting the Edit Dot Parameters window.





Manual Dispense Program Scripting

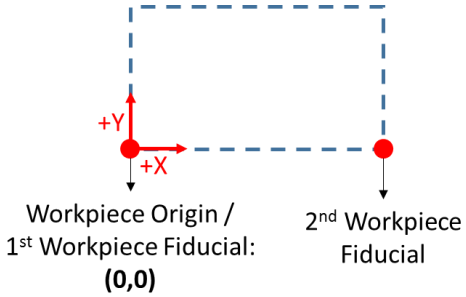
This programming procedure only controls the nozzle scan path / dispense locations and pauses between dispensed beads. As a consequence, nozzle-to-substrate gap cannot be continuously adjusted during dispense of a line. See the section **"Dispense Parameter Programming"** for instructions on programming dispensing parameters (scan speed, nozzle-to-membrane gap, fluid pressure, etc…).

In the following example, the program is set up to perform alignment prior to execution through the location of two fiducials. However, alternative fiducial alignment schemes are possible within the software.

Unless otherwise noted, all coordinate locations are absolute commands relative to the origin specified at the start of program execution.

1. Workpiece / main program definition:
    a. **By default, the program starts and ends execution based on the set of scripted commands in the "Workpiece" sub-routine.**

b. Pick two locations on the dispenser stage to use as the **workpiece origin / 1st workpiece fiducial** and the **2nd workpiece fiducial**. Ideally, these two locations will be the bottom two corners of the intended workpiece footprint:



c. On the "FmXP" main menu, click "Teach a Program".

d. On the top menu of the programming window, select "File" > "New". Then select "Two" as the number of fiducials and press "OK".

e. On the pop-up window ("Teach first point defining axis"), move the stage until the crosshair is aligned with the desired **workpiece origin / 1st workpiece fiducial** location in the camera image, then press "Teach".

f. On the pop-up window ("Teach second point defining axis"), move the stage until the crosshair is aligned with the desired **2nd workpiece fiducial** location in the camera image, then press "Teach".

g. On the pop-up window ("Teach workpiece origin"), move the stage until the crosshair is aligned with the desired **1st workpiece fiducial** location in the camera image, then press "Teach" and "Done".

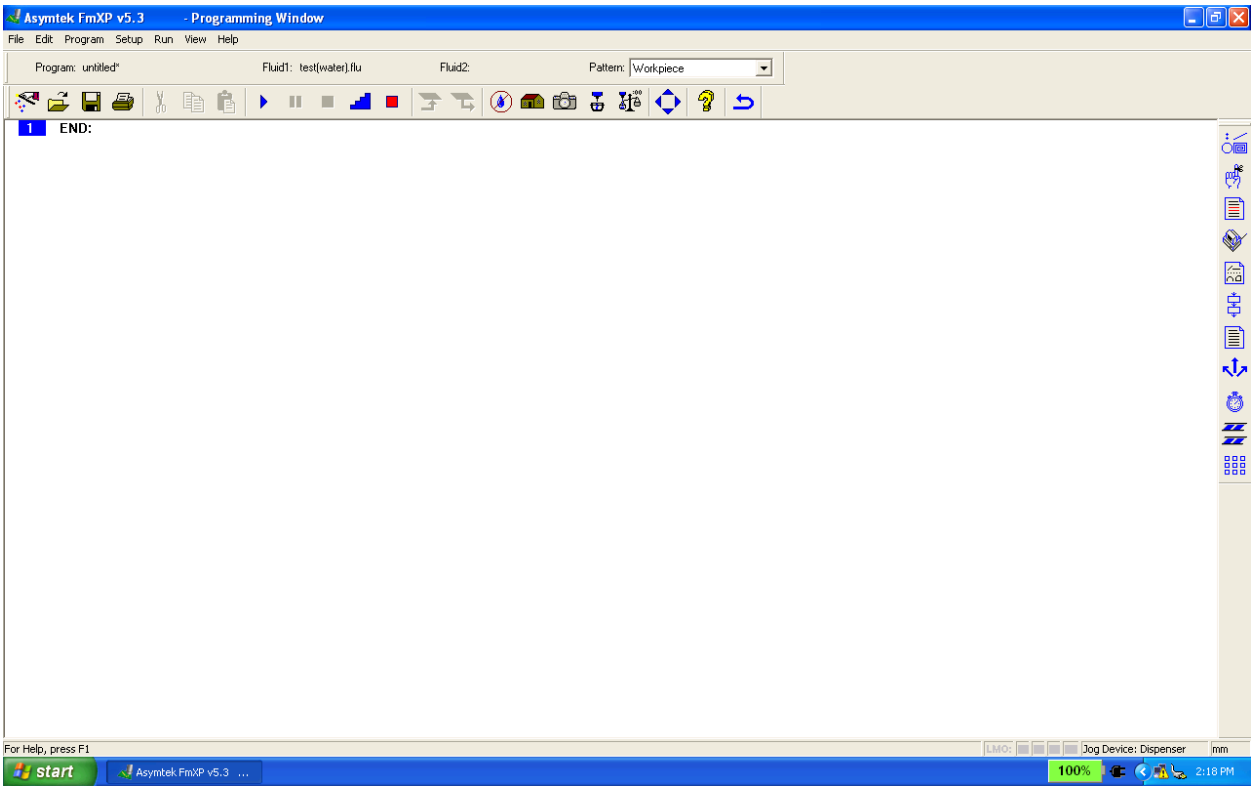
h. On the pop-up window ("Select method to find Fid 1"), select the "Manual Fiducial" radio button, then press "Next".

i. On the pop-up window ("Jog to Fid 1, then press Teach…"), move the stage until the crosshair is aligned with the desired **1st workpiece fiducial** location in the camera image, then press "Teach".

j. On the pop-up window ("Select method to find Fid 2"), select the "Manual Fiducial" radio button, then press "Next".

k. On the pop-up window ("Jog to Fid 2, then press Teach…"), move the stage until the crosshair is aligned with the desired **2nd workpiece fiducial** location in the camera image, then press "Teach".

l. There should now be a blank window displayed entitled “Programming Window” as shown below. This window is where the main dispensing pattern is scripted. Code can’t be typed directly into the window. Instead, consult the following steps as a guide for inputting specific scripted commands into the window / program.



m. Scripting commands to accomplish:

i. Detection of substrate z-height / z-origin at location X,Y

1. The dispenser gantry detects substrate z-height by extending a stiff metal probe to contact the surface at a location X,Y, and then automatically sets z = 0 based on the point of impact.
2. Select “Program” > “Process Commands” > “Find Substrate Height” on the top menu of the programming window. Then type in the desired X & Y coordinates, and press “Go to”, “Teach” and “Done”. This results in a single line of code displayed as “FIND SUBSTRATE HEIGHT: (X,Y)” on the programming window.

ii. Movement of the dispenser nozzle to machine coordinates X,Y

1. Select “Program” > “Motion” > “Move Abs X,Y” on the top menu of the programming window. Then type in the desired X & Y

machine coordinates, and press “Go to”, “Teach” and “Done”. This results in a single line of code displayed as “MOVE ABS XY: (X,Y)”.

iii. Movement of the dispenser nozzle to machine Z coordinate

1. Select “Program” > “Motion” > “Move Abs Z” on the top menu of the programming window. Then type in the desired machine Z coordinate, and press “Go to”, “Teach” and “Done”. This results in a single line of code displayed as “MOVE ABS Z: (Z)”.

iv. Dispense of a single fluid dot at location X,Y

1. The **“Dot Style”** in this command refers to a pre-defined set of dot dispense parameters (See section **“Dispense Parameter Programming”** for details)
2. Select “Program” > “Dot” on the top menu of the programming window. Then type in the desired X & Y coordinates and select the desired “Type” from the “Dot Style” drop down menu. Then press “Go to”, “Teach”, and “Done”. This results in a single line of code displayed as “DOT: #, (X,Y)”.
    a. # represents the selected “Type” in the “Dot Style” menu

v. Dispense of a single fluid line with start and end points (X1,Y1) and (X2,Y2).

1. The **“Line Style”** in this command refers to a pre-defined set of line dispense parameters (See section **“Dispense Parameter Programming”** for details)
2. Select “Program” > “Line” on the top menu of the programming window. Then type in the desired start point X1 & Y1 coordinates, desired end point X2 & Y2 coordinates, and select the desired “Type” from the “Line Style” from the drop down menu. Then press “Go to” for both the start point and end point, followed by “Teach” and “Done”. This results in a single line of code displayed as “LINE: #, Start:(X1,Y1), End:(X2,Y2)”.
    a. # represents the selected “Type” in the “Line Style” menu

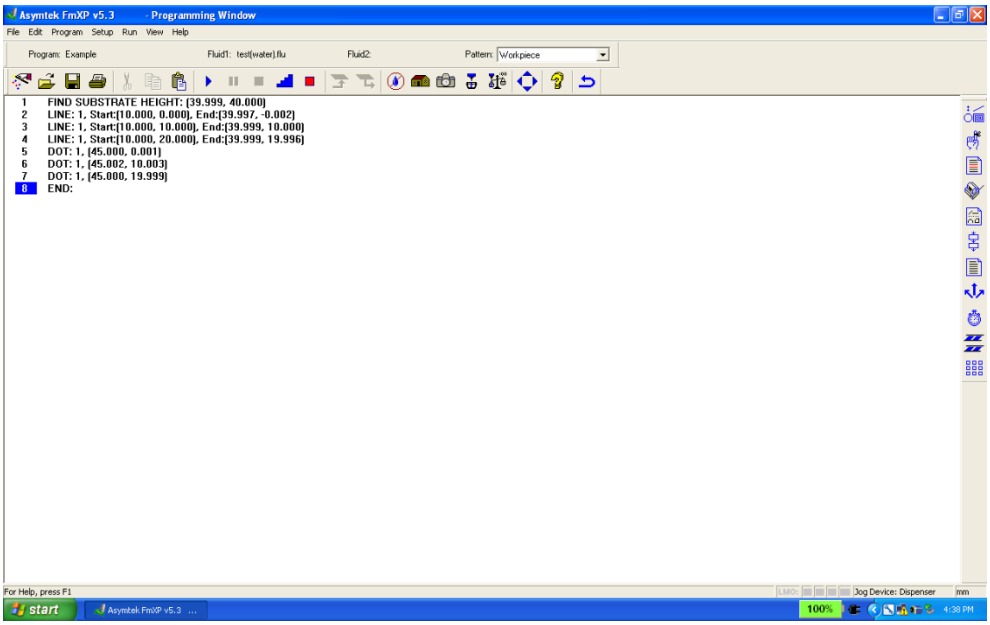
vi. Program pause until the user manually resumes execution

1. Select “Program” > “Time Commands” > “Pause” on the top menu of the programming window. Then type in the desired pause <Text>, and press “OK”. This results in a single line of code displayed as “PAUSE: <Text>”.
2. When this code is executed, the program pauses operation and displays a pop up window with an option for the operator to press the “Continue” button to resume program execution.

vii. Program pause for a duration of T seconds.

1. Select “Program” > “Time Commands” > “Wait” on the top menu of the programming window. Then type in the desired wait time T and WAIT message <Text>, and press “OK”. This results in a single line of code displayed as “WAIT: T second(s) - <Text>”.
2. When this code is executed, the program pauses operation for a duration equal to T seconds, and then resumes execution. While paused, a pop up window is displayed with text.

n. After scripting various commands, the Programming Window should display code similar to the example shown below:



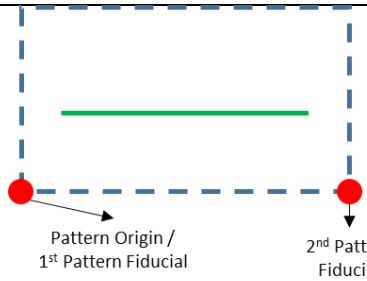
2. Creating and adding an instance of a pattern to the workpiece (OPTIONAL)

a. **In addition to scripting commands directly into the main "Workpiece" Programming Window, a set of commands can be written as a separate user-defined sub-routine within the program. This set of commands is called a "Pattern". To execute this pattern within a program, a single line command can be scripted into main "Workpiece" Programming Window.**
    i. **This is useful if there a series of commands which is repeated many times within a workpiece.**
b. Pick two locations on the dispenser stage to use as the **pattern origin / 1st pattern fiducial** and the **2nd pattern fiducial**.
c. On the top menu of the programming window, select "Program" > "Pattern" > "Create".
d. On the pop-up window ("Create Pattern"), enter the desired pattern name (e.g. "Pattern 1"). Then select "Two" as the number of fiducials and press "OK".
e. On the pop-up window ("Teach pattern origin…"), move the stage to the designated **pattern origin / 1st pattern fiducial** location. Then press "Teach" and "Done".
f. On the pop-up window ("Select method to find Fid 1, then press Next."), select the "Manual Fiducial" radio button. Then press "Next"
g. On the pop-up window ("Jog to Fid 1, then press Teach…"), leave the stage in the same (**1st pattern fiducial**) location. Then press "Teach".
h. On the pop-up window ("Select method to find Fid 2, then press Next"), select the "Manual Fiducial" radio button. Then press "Next"
i. On the pop-up window ("Jog to Fid 2, then press Teach…"), move the stage to the designated **2nd pattern fiducial** location, then press "Teach". The pop-up window should disappear, leaving just the Programming Window.
j. On the Programming Window select "Program" > "Pattern" > "Place" on the top menu.
k. In the resulting pop-up menu, select the desired pattern to place from the "Available Patterns" area of the pop-up window.
l. Set the (X,Y) placement and rotation (θ) of this pattern instance relative to the workpiece origin in the program:

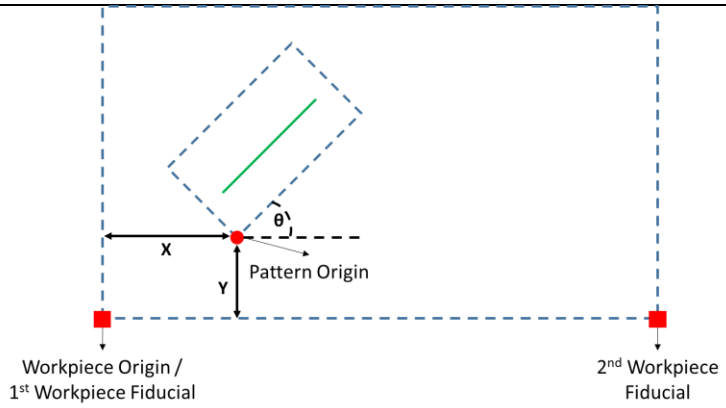
i. To rotate the pattern coordinates θ degrees relative to the main workpiece, check the "Use Rotation" box, and specify the amount of rotation in the "degree(s)" text field.

ii. To place the pattern origin in a specific (X,Y) location relative to the workpiece origin, select the bottom button below "Location:" and enter in the X and Y coordinates.

iii. The placement of the pattern relative to the workpiece origin appears as shown in the following figure:



Pattern (as programmed during editing)

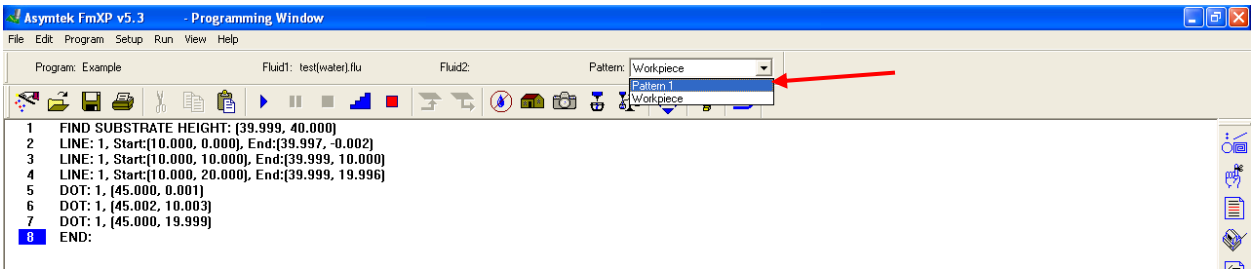


Pattern as executed in program after placement within "Workpiece"

m. Press "GoTo", "teach", then "Done". This results in a single line of code displayed as "DO: Pattern 1 AT (X, Y), θ".

3. Editing a pattern (OPTIONAL):

i. Near the top of the Programming Window select the previously created pattern name (in this case "Pattern 1") from the "Pattern" dropdown menu:



ii. Press “OK” on the pop-up window asking to move to the Reference Origin of “Pattern 1”

iii. The resulting Programming Window will display all the scripted commands within the selected Pattern. Enter scripted commands as previously described.

4. Deleting a pattern (OPTIONAL):
    a. On the Programming Window, select “Edit” > “Delete Procedure / Pattern”. Then select the pattern to be deleted and press “OK”.
5. To save the scripted code, select “File” > “Save As” on the top menu of the window and chose a file location. Then save the dispensing process file with the desired name.
    a. All dispense program files will have the extension **“*.fmw”**
    b. All user-created patterns are stored within the program file
6. To return to the FmXP main menu, press the icon on the programming window top menu

Dispensing Program Execution

1. On the FmXP main menu, click “Teach a Program”. Then on the top menu of the programming window, click “File” > “Open”.
2. Open the desired previously programmed dispensing program (the file will have a “*.fmw” extension)
3. On the top menu of the programming window, click “Edit” > “Edit Line Parameters”. Check to make sure the each “Line Type” referred to in the dispensing program code shown in the programming window has the correct line parameters listed. After making the necessary adjustments (if applicable), press “Apply”, “OK”, then exit the line parameters window.
4. On the top menu of the programming window, click “Edit” > “Edit Dot Parameters”. Check to make sure that each “Dot Type” referred to in the dispensing program code shown in the

programming window has the correct line parameters listed. After making the necessary adjustments (if applicable), press “Apply”, “OK”, then exit the line parameters window.

5. Press the start icon () to start program execution. The program will ask the operator to first align the two previously defined **workpiece fiducials**, and the pair of predefined **pattern fiducials** for each user-created pattern within the program. After fiducial alignment, the program will perform the instructions written into the displayed code. To abort the program during execution, press the abort icon ().
6. To return to the FmXP main menu, press the  icon on the programming window top menu

Dispensing Tool Shutdown

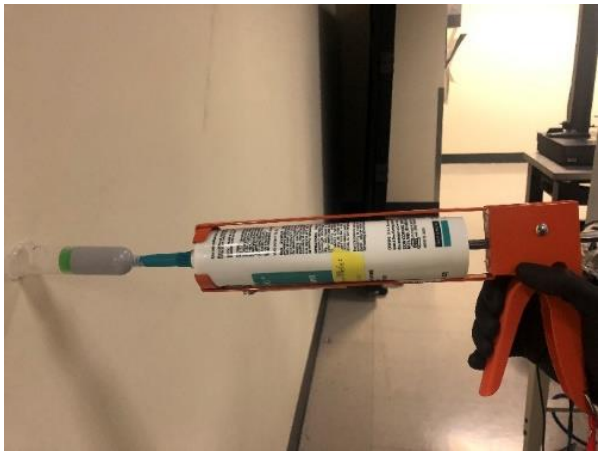
1. On the FmXP main menu, press the “Exit” icon
2. Once the FmXP program is exited, turn off the laptop
3. Turn off the dispenser by pressing the black button on the dispenser front panel, and then flipping the switch on the dispenser back panel

4. Shut off the nitrogen gas intake
5. Store the fluid syringe barrel according to the supplier recommendations

Appendices:

A Note on Filling Syringe Barrels with Viscous Fluids

For viscous fluids, to avoid the risk of trapping air bubbles within the syringe, it is recommended that syringes be filled from the bottom with the syringe barrel piston already inserted. An example of this filling procedure is shown below for a 30 cc syringe barrel using a silicone adhesive cartridge (Dow Corning 3165 Fast Tack RTV Adhesive Sealant 1/10 gal) and caulking gun. In this case, the tip of the cartridge was cut off to leave a hole just large enough to fit over the syringe barrel tip.



Example of viscous fluid line dispense parameters (Dow Corning 3165 Fast Tack RTV Adhesive Sealant)

Below is an example of the line dispense parameters for a typical viscous adhesive deposition process, including past observations on methods for optimizing deposited bead dimensional control. Unless otherwise noted, all tool operation procedures are identical to that outlined in the “System Operation for Basic Dispensing Process Programming and Execution” section.

For optimal dimensional control of the dispensed bead, the scan speed should be set equal to the estimated speed of fluid exiting the nozzle. This is achieved by taking the overall average mass flow rate measured from several dispense purge trials, and then calculating the average speed

of fluid exiting the nozzle. The dispense scan speed is then set equal to this calculated average nozzle fluid exit speed.

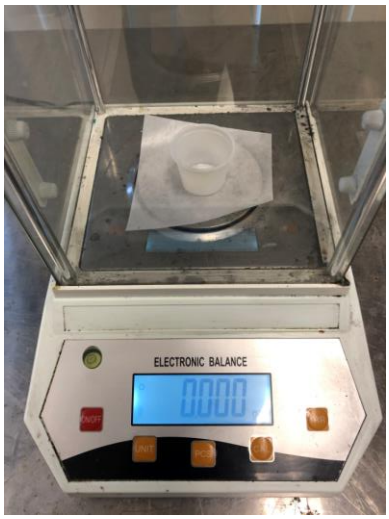
Note that this example assumes that dispense is done with a plain syringe barrel with no shut-off valve.

1. Line Dispense Parameters for Dow Corning 3165 Fast Tack RTV Adhesive Sealant
    a. During the dispensing parameter setting process (as described in the "Dispense Parameter Programming" subsection of the main procedure), set the line parameters as shown in the following table.
        i. The "Dispense fluid pressure" parameter is set by turning the gray knob until the fluid pressure display on the dispenser's front panel reads 70 psi, as indicated in the "Dispense Parameter Programming" subsection of the main procedure.
        ii. The "Speed" parameter value ($v_{s,expt}$) is set based on the average experimentally measured dispense mass flow rate for the given dispense fluid pressure (70 psi), as shown in the next subsection.

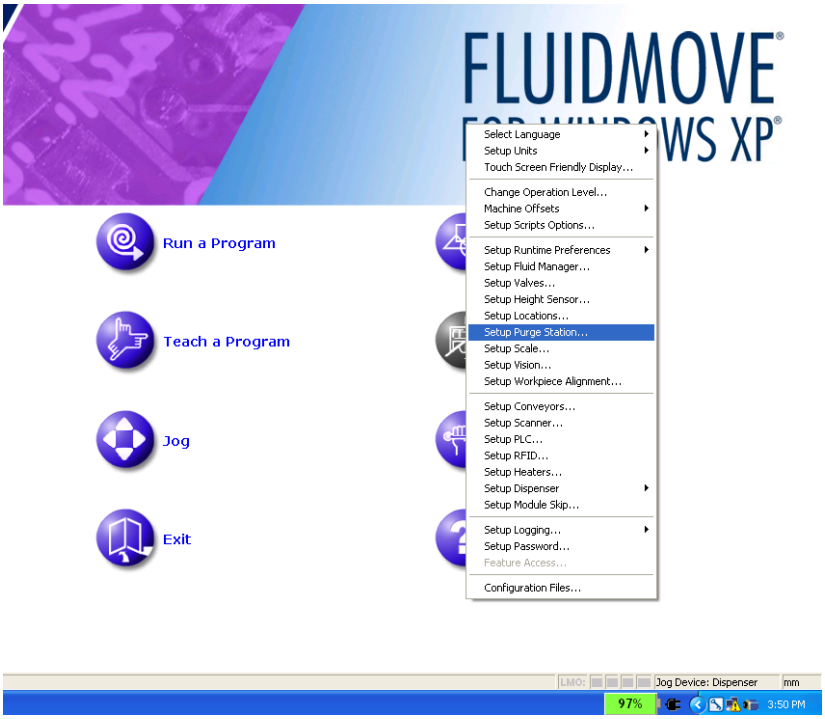
Parameter	**Value**
Dispense fluid pressure	70 psi
Nozzle tip type / diameter	1.2 mm inner diameter (Fisnar QuantX™ 8001270 Tapered Dispensing Tip Gray 16 ga)
Pre-move delay factor	0.2 s
Down speed	50.8 mm/sec
Down acceleration	7619.996 mm/s^2
Dispense gap	1.6 mm
Speed	$\boldsymbol{v_{s,expt}}$
Shut-off distance	1.0 mm
Suckback	N/A
Dwell	0.5 s
Backtrack gap	5 mm
Backtrack length	50 mm
Backtrack speed	700 mm/s
Retract distance	5 mm

Retract speed	500 mm/s
Retract acceleration	15000 mm/s^2

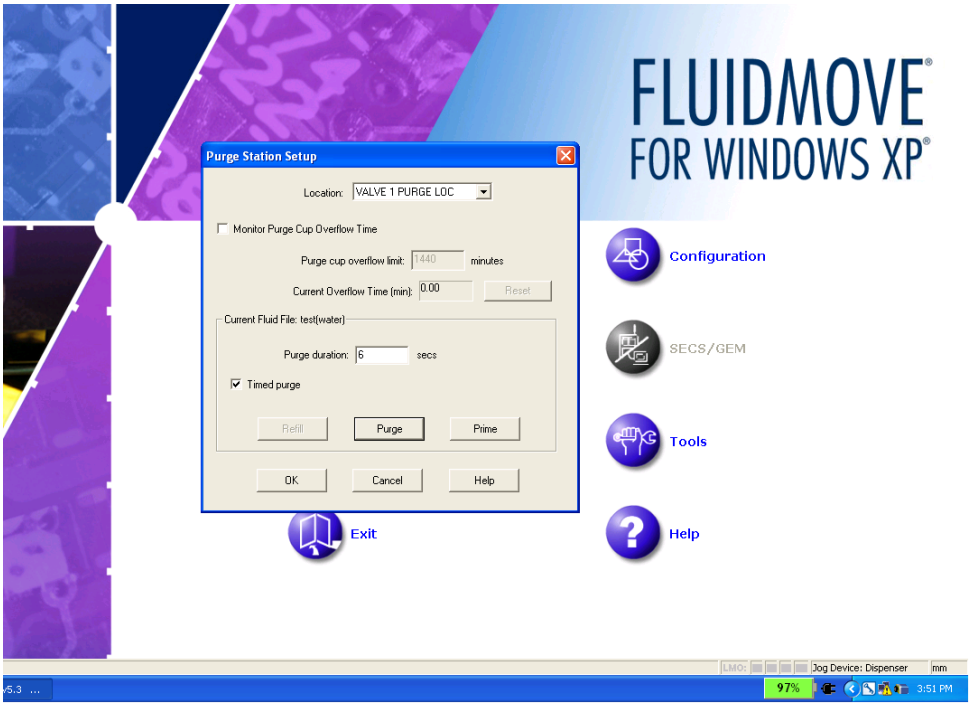
2. Calculating the Experimental Dispensing Scan Speed at 70 psi Dispense Fluid Pressure:
    a. Place a plastic cup on a microbalance and tare the mass so that the balance reads 0 g, as shown below.



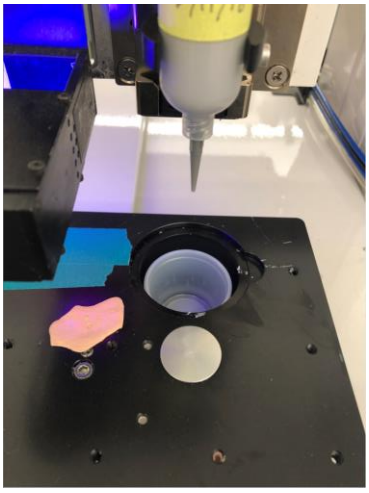
    b. On the dispenser's front panel, adjust the gray knob until the fluid pressure display reads 70 psi.
    c. On the FmXP main screen, click "Configuration". Then click "Setup Purge Station…", as shown below.



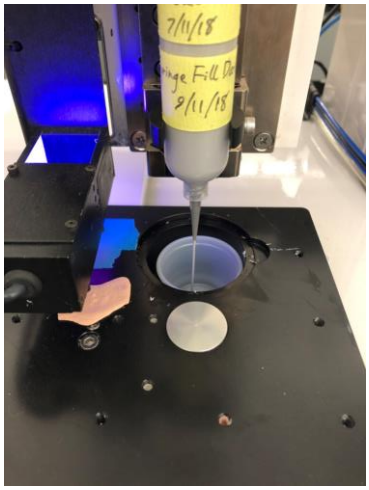
d. On the resulting pop-up “Purge Station Setup” window, ensure that the “Location” pull-down menu reads ‘VALVE 1 PURGE LOC”. Then set the purge duration to 6 seconds and click the “Timed purge” box.



e. Place the previously weighed plastic cup in the valve 1 purge location as shown below:



f. Press the “Purge” button. This will cause the dispenser to move the designated purge location and dispense fluid for 6 seconds, as shown below:



g. Using the same microbalance that was previously tared, measure the resulting dispensed purge fluid mass.

h. Calculate the trial purge mass flow rate $\dot{m}_{purge}$ as m_{purge}/t_{purge}, where m_{purge} is the measured dispense purge fluid mass in grams, and t_{purge} is the dispense purge duration (in this case 6 seconds).

i. Repeat steps a. through h. four more times to yield four more trial mass flow rate values.

j. Determine the average of the five resulting mass flow rate trials in g/mL. This average mass flow rate will be designated by $\bar{\dot{m}}_{purge}$.

k. Calculate the ideal experimental dispensing scan speed $v_{s,expt}$ by matching the scan speed to the estimated speed of fluid exiting the nozzle at the target dispensing pressure (in this case 70 psi). This calculation can be achieved with the equation below.

$$v_{s,expt} = \frac{4}{\pi D^2} * \frac{1000\bar{\dot{m}}_{purge}}{\rho}$$

Where D is the dispense nozzle tip inner diameter in mm, and ρ is the fluid density in g/mL.

3. Observations of Dow Corning 3165 Fast Tack RTV Adhesive Sealant Behavior:

a. In general, bead dimensions are primarily affected by the "Dispense fluid pressure", "Nozzle tip type / diameter", "Dispense gap", and "Speed" parameters. Larger bead dimensions (i.e. height and width) occur with a larger nozzle tip, slower scan speed, and higher fluid pressure.

i. As previously noted, to minimize bead dimensional variability it is recommended that the scan speed be matched to the rate of fluid exiting the dispensing nozzle tip.

b. Due to the lack of a shut-off valve, defects often appear in deposited beads of Dow Corning 3165 Fast Tack RTV Adhesive Sealant. These include bulges at the start of beads and wisps at the end of beads. Both defects are shown below.

	
Bulge side view (left end of dispensed bead)	Wisp side view (right end of dispensed bead)

i. While these defects cannot be completely eliminated without a shut-off valve, the size of bulges is primarily affected by the “Pre-move delay factor”. Similarly, the size of wisps is primarily affected by the “Shut-off distance”, “Dwell”, “Backtrack gap”, “Backtrack length”, and “Backtrack speed”.